

The larval development of *Crangon crangon* (Fabr. 1795) (Crustacea: Decapoda)

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Introduction

The first larval stage of *Crangon crangon* (Fabr., 1795) was recorded by Du Cane in 1839 and since then descriptions of some of the subsequent larval stages have been added. In 1890 Ehrenbaum described five larval stages but suggested, as they were taken from plankton samples, that his series may not have been complete. Williamson (1901) reared the first three stages in the laboratory, and selected examples from tow net plankton samples concluding that there were probably five larval stages in all. Experimental evidence on the development of larvae under non-circadian light/dark cycles given by Dalley (1980), also suggested there were five larval stages. The present study is based on specimens reared in the laboratory, and describes six larval stages, one more than those previously recorded.

Materials and method

Ovigerous *Crangon crangon* (Fabr., 1795) were trawled in the Sound, Plymouth, in March, 1980. Rearing techniques follow those of Fincham, 1977. Representatives of each stage are deposited in the Crustacea collections of the British Museum (Natural History), registration numbers 1981 : 394-400.

Description of larval stages

Key characters are printed in *italic type*; many setal counts have been omitted but these are recorded in Table 1.

ZOEA 1 (Fig. 1) mean size 2 mm

Head (Figs 1a, b): eyes are sessile.

Carapace (Figs 1a, b): without spines; rostrum short.

Antenna 1 (Fig. 1c): *single peduncle segment* bearing external flagellar segment with *three aesthetascs* distally plus one seta; terminal setose spine on peduncle segment.

Antenna 2 (Fig. 1d): exopodite broad and flat with *ten setae*, *all plumose except the penultimate, subapical medial spine absent*; endopodite with terminal spinous seta; spine on distal edge of peduncle segment at base of endopodite.

Mandibles (Fig. 1e): symmetrical.

Maxilla 1 (Fig. 1f): coxa with seven spines; basis with five spines; endopod with five setae plus one small spine.

Maxilla 2 (Figs 1g, h): endopod coxa bilobed on inner margin, *proximal lobe with six setae*, distal lobe with four setae; basis one with four setae; basis two with four setae, endopodite with four lobes on inner margin, fourth proximal lobe with three setae, third sub proximal lobe with two setae, second subdistal lobe with one seta, distal lobe with two setae; *exopodite with five setae*.

Maxillipeds 1–3 (Figs 1i–l): with natatory exopodites.

Pereiopod 1 (Fig. 1m): *rudimentary, biramous*.

Pereiopods 2–4 (Figs 1m): *rudimentary, uniramous*.

Pereiopod 5: *absent*.

Abdomen (figs 1a, b): 5 somites, *6th somite continuous with telson*.

Telson (Fig. 1n): *fans out distally, distal margin with 7 + 7 terminal plumose spines*.

ZOEA 2 (Fig. 2) mean size 2.4 mm

Head (Figs 2a, b): *eyes 'stalked'*.

Antenna 1 (Fig. 2c): *peduncle two segmented; internal distal margin of second segment extended*.

Pereiopod 1 (Fig. 2m): *1-segmented endopod with one apical seta; natatory exopodite*.

Telson (Fig. 2o): *distal margin with 8 + 8 terminal plumose spines*.

ZOEA 3 (Fig. 3) mean size 3.0 mm

Antenna 1 (Fig. 3c): *external flagellum with four distal aesthetascs, one narrower than others and one distal seta*.

Pereiopod 1 (Fig. 3k): *2-segmented endopodite*.

Telson (Fig. 3n): *divided from somite 6 by suture; exopod and endopod of uropod with fringing plumose setae*.

ZOEA 4 (Figs 4 & 5) mean size 3.5 mm

Antenna 1 (Fig. 4c): *rudimentary stylocerite*.

Pereiopod 1 (Fig. 5d): *3-segmented endopodite*.

Abdomen (Fig. 4b): *rudimentary buds of pleopods on somites 1–5*.

ZOEA 5 (Figs 6 & 7) mean size 4.1 mm

Antenna 1 (Fig. 6c): *external flagellum segment with 4 wide distal aesthetascs and one narrow sub-distal aesthetasc plus one setule*.

Pereiopod 1 (Fig. 7d): *4-segmented endopodite*.

Pereiopods 2–3 (Fig. 7e): *uniramous 1-segmented*.

Pereiopod 4 (Fig. 7f): *uniramous 4-segmented*.

Pereiopod 5 (Fig. 7g): *uniramous 5-segmented*.

ZOEA 6 (Figs 8 & 9) mean size 4.2 mm

Pereiopod 1 (Fig. 9d): *5-segmented endopodite*.

Pereiopods 2–5 (Figs 9e–f): *uniramous 6-segmented*.

POST LARVA 1 (Figs 10–12) mean size 4.4 mm

Carapace (Figs 10a, b): *rostrum short; one dorso-medial tooth*.

Antenna 1 (Fig. 10c): *3-segmented peduncle; external flagellum 2-segmented with four distal and two sub-distal aesthetascs, internal flagellum 3-segmented; stylocerite with terminal plumose setae*.

Antenna 2 (Fig. 10d): *exopodite with 19 plumose setae; endopodite multisegmented*.

Mandibles (Fig. 10e): *symmetrical*.

Maxilla 1 (Fig. 10f): *coxa with 5 spines; basis with 9 spines plus one plumose seta; endopod with one spine*.

Maxilla 2 (Fig. 10g): *endopod reduced; exopod > 22 plumose setae*.

Maxilliped 1 (Fig. 11a): *endopod reduced with one plumose seta; exopod with 3 short plumose setae distally plus one seta, one plumose seta proximally; epipodite present*.

Maxilliped 2 (Figs. 11b, c): *endopod 5-segmented, exopod with reduced setae*.

Maxilliped 3 (Fig. 11d): *endopod 3-segmented; exopod with very reduced plumose setae*.

Pereiopod 1 (Figs 11e, f): *exopod reduced; endopod 4-segmented, propodus and dactylus subchelate*.

Pereiopod 2 (Fig. 11g): *5-segmented, chelate; epipodite present*.

Pereiopod 3 (Figs 11h, i): *7-segmented*.

Table 1 Morphological comparison of larval stages 1–6 and post larva. (v = visible; d = developed; a = absent; p = present; r = rudimentary; b = biramous; re = reduced)

ZOEAL STAGE	1	2	3	4	5	6	PL
MEAN SIZE	2.0 mm	2.4 mm	3.0 mm	3.5 mm	4.1 mm	4.2 mm	4.4 mm
ANTENNA 1							
No. of aesthetascs.	3	3	4	4	5	6	6
Stylocerite.	a	a	a	v	v	v	d
No. of segments.	1	2	2	2	2	2	3
ANTENNA 2							
Presence of subapical medial spine.	a	p	p	p	p	p	p
Exopodite; no. of plumose setae incl. fine setae immediately after spine.	10	11	12–13	13–14	13–14	14–16	19
MAXILLA 1							
No. of setae on coxa;	7	7	7	7	8	8	1
basis;	5	7	8	8	9	9	10
endopod.	5+1	5+1	5+1	5+1	5+1	5+1	4+1
MAXILLA 2							
No. of endite setae on endopodite lobes 1, 2, 3, 4;	2.1.2.3	2.1.2.3	2.1.2.3	2.1.2.3	2.1.2.3	2.1.2.3	re
basis 1;	4	4	4	4	4	4	re
basis 2;	4	4	4	4	4	4	re
coxa (prox. & distal).	6+4	7+4	7+4	7+4	7+4	7+4	re
No. of plumose setae on exopodite.	5	10	10–13	13–15	15–19	20–22	>22
MAXILLIPED 1							
No. of setae on endite of coxa;	4	5	5	5	5	5	re
basis.	11	13	14	14	14	14	re
No. of plumose setae on exopodite.	4	5	5	5	5	5	re
PEREIOPOD 1							
No. of segments in endopodite.	r/b	1	2	3	4	5	4
No. of setae on endopodite.	a	1	2	v	v	v	–
Presence of natatory exopodite.	a	p	p	p	p	p	re
PEREIOPOD 2							
No. of segments.	r	r	r	r	r	6	5
No. of setae.	–	–	–	–	1	1	–
PEREIOPOD 3							
No. of segments.	r	r	r	r	r	6	7
No. of setae.	–	–	–	–	1	1	–
PEREIOPOD 4							
No. of segments.	r	r	r	r	4	6	7
PEREIOPOD 5							
No. of segments.	a	r	r	r	5	6	7
ABDOMEN							
Somite 6—distal suture present.	a	a	p	p	p	p	p
TELSON							
No. of segments.	14	16	16	16	16	16	10
UROPODS							
Presence.	a	a	p	p	p	p	p

Pereiopod 4 (Figs 11j, k): 7-segmented.

Pereiopod 5 (Figs 11l, m): 7-segmented.

Pleopod 1 (Fig. 12a): inner margin of exopod with 6 plumose setae, 2 apical setae, external margin with 4 plumose setae.

Pleopods 2-4 (Figs 12b-d): exopod inner margin 6 plumose setae, 2 apical setae, external margin with 5 plumose setae.

Pleopod 5 (Fig. 12e): exopod inner margin with 5 plumose setae, 2 apical setae, external margin with 4 plumose setae.

Telson (Fig. 12f): 5 + 5 spines; exopod of uropod with one spine next to subapical medial spine.

Discussion

The larval stages of *Crangon crangon* (Fabr., 1795) have not previously been described solely from laboratory reared material. Williamson (1901) figured his larval series from the first three stages reared in the laboratory, supplemented by larval stages four and five and the post larva taken from plankton samples. All earlier records indicate five larval stages. In the present work six larval stages are produced consistently under laboratory conditions. The insertion of an additional larval stage prolonging development is a feature shared by other carideans (Fincham, 1977). In planktonic larvae delaying the onset of metamorphosis until conditions are favourable provides the maximum chance of survival for the mainly benthic juveniles.

Minor differences related to the insertion of an additional larval stage become apparent when comparisons to Williamson's (1901) work are made. The numbers of aesthetascs recorded in this paper accord with Williamson up to stage four when he then records 6 (4 distal and 2 subdistal) compared with 5 aesthetascs (4 distal and 1 subdistal) for stage 5; 7 (4 distal and 3 subdistal) in first post larva compared with 6 (4 distal and 2 subdistal) in post larva recorded here. Maxilliped 1 showed variation in the early stages. Williamson records 10 spines on the basis in stage 1, 12 in stage 2, 13 in stage 3 compared with 11 in stage 1, 13 in stage 2 and 14 in stage 3 recorded here. Pereiopods 2-5 in the last two larval stages differed in segmentation. Williamson showed stage 4 pereiopod 2 as 1-segmented, pereiopod 3 as 3-segmented and pereiopods 4 and 5 as 2-segmented; stage 5 pereiopods 2-5 as 7-segmented. Recorded in this paper stage 5 pereiopod 2 is rudimentary, pereiopod 3 is 1-segmented, pereiopod 4 is 4-segmented and pereiopod 5 is 5-segmented; stage 6 pereiopods 2-5 are 6-segmented. These differences are almost certainly related to the insertion of the extra larval stage after stage 2 prior to metamorphosis.

References

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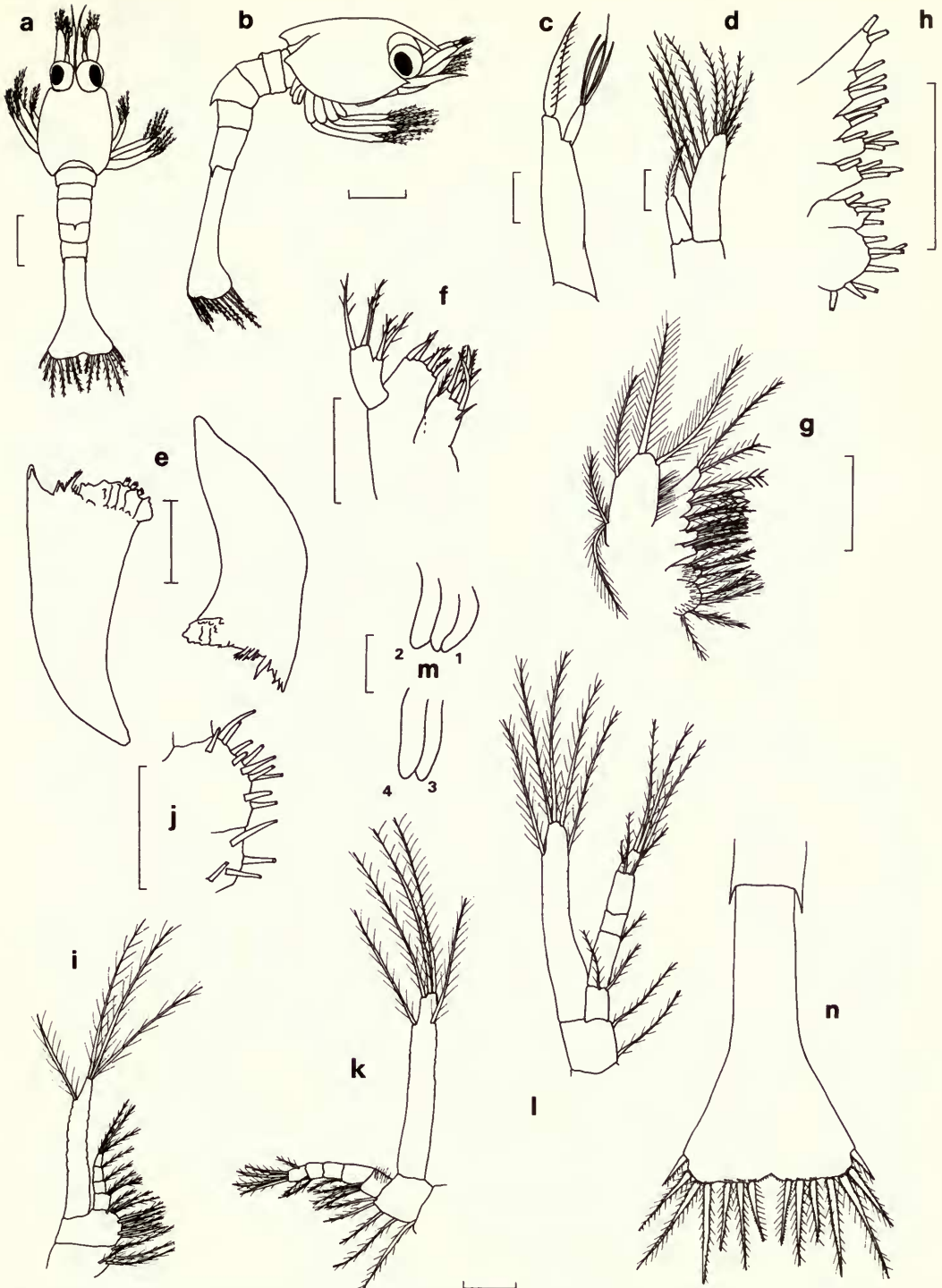


Fig. 1 Zoea 1: (a) dorsal view; (b) lateral view; (c) antenna 1; (d) antenna 2; (e) mandibles; (f) maxilla 1; (g) maxilla 2; (h) armature of maxilla 2; (i) maxilliped 1; (j) armature of maxilliped 1; (k) maxilliped 2; (l) maxilliped 3; (m) pereiopods 1-5; (n) telson.
 Bar scales: a, b = 0.35 mm; c-n = 0.1 mm.

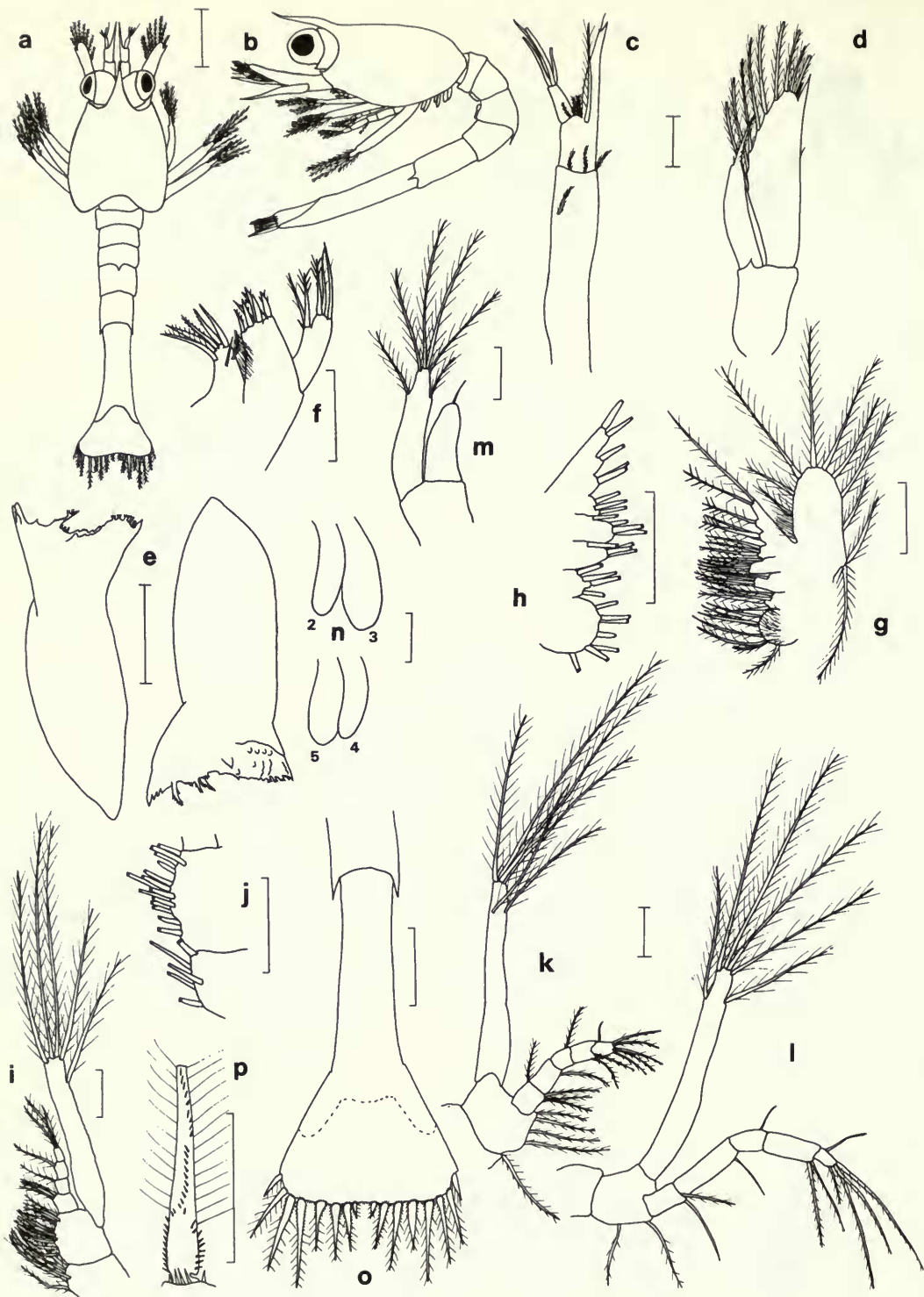


Fig. 2 Zoea 2: (a) dorsal view; (b) lateral view; (c) antenna 1; (d) antenna 2; (e) mandibles; (f) maxilla 1; (g) maxilla 2; (h) armature of maxilla 2; (i) maxilliped 1; (j) armature of maxilliped 1; (k) maxilliped 2; (l) maxilliped 3; (m) pereiopod 1; (n) pereiopods 2-5; (o) telson; (p) detail of spine, 3rd from right, on telson.
 Bar scales: a, b = 0.3 mm; c-p = 0.1 mm.

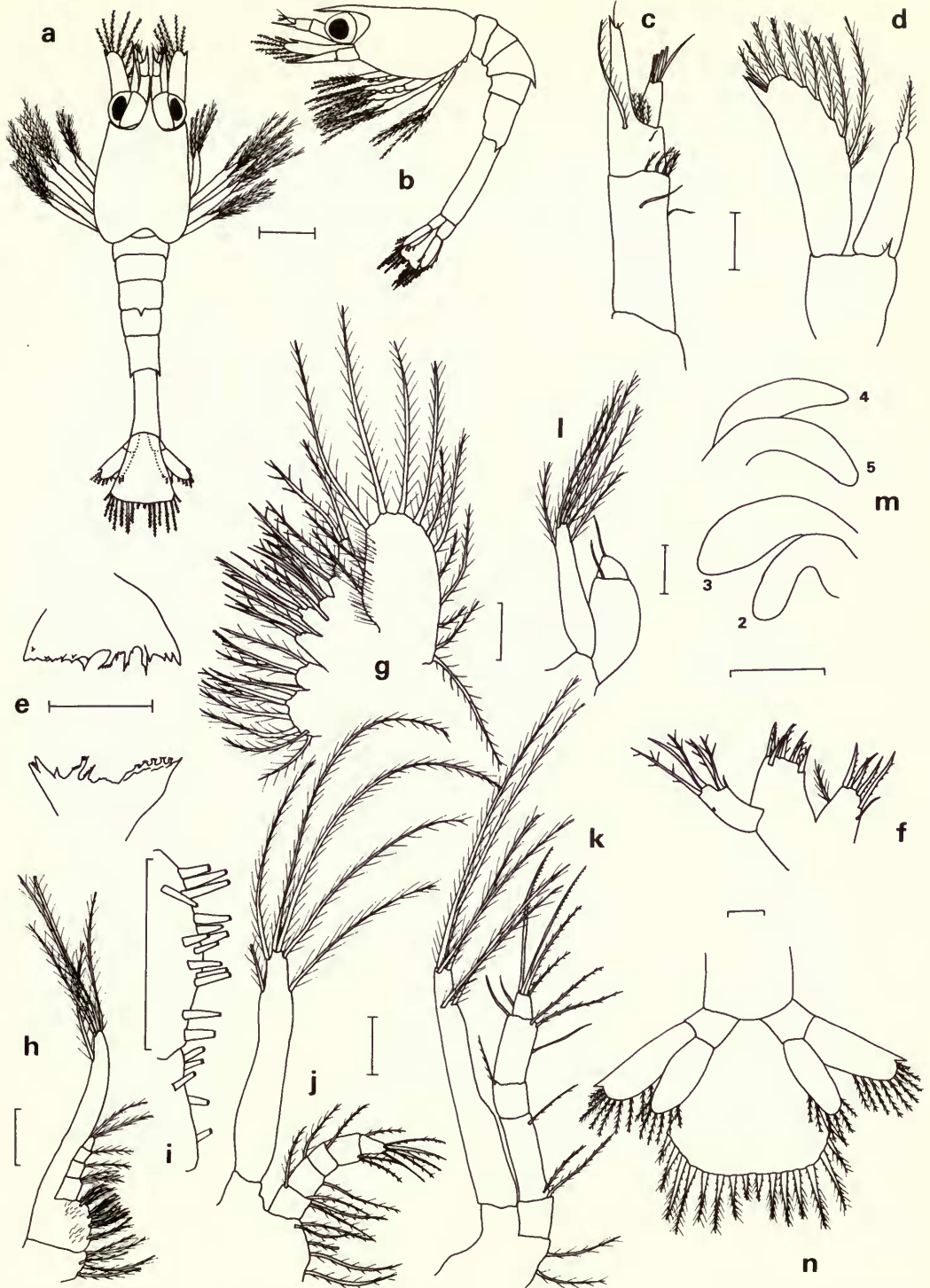


Fig. 3. Zoea 3: (a) dorsal view; (b) lateral view; (c) antenna 1; (d) antenna 2; (e) mandibles; (f) maxilla 1; (g) maxilla 2; (h) maxilliped 1; (i) armature of maxilliped 1; (j) maxilliped 2; (k) maxilliped 3; (l) pereiopod 1; (m) pereiopods 2-5; (n) telson.
 Bar scales: a, b = 0.2 mm; c-g = 0.1 mm.

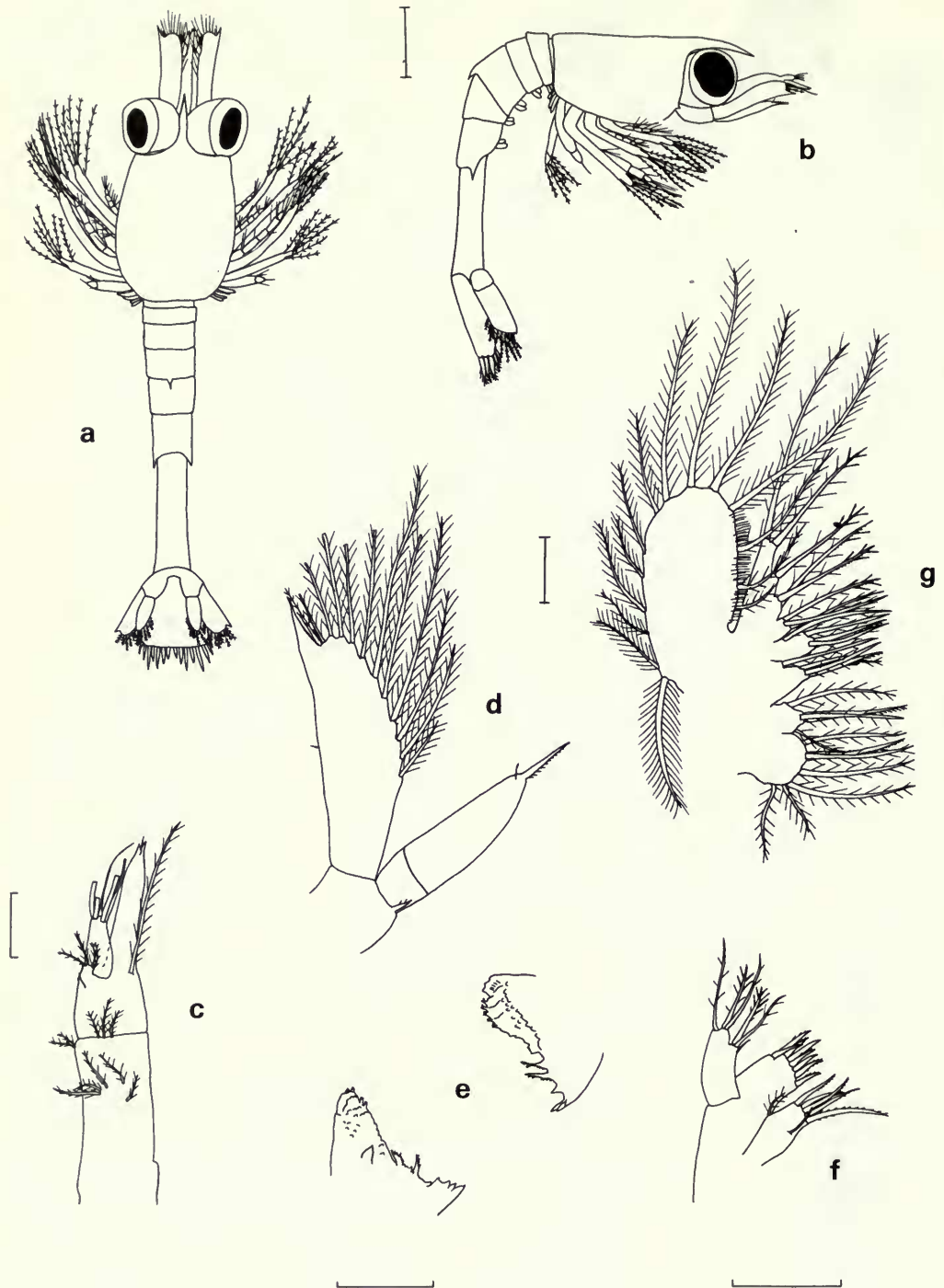


Fig. 4. Zoea 4: (a) dorsal view; (b) lateral view; (c) antenna 1; (d) antenna 2; (e) mandibles; (f) maxilla 1; (g) maxilla 2. Bar scales: a, b = 0.3 mm; c-g = 0.1 mm.

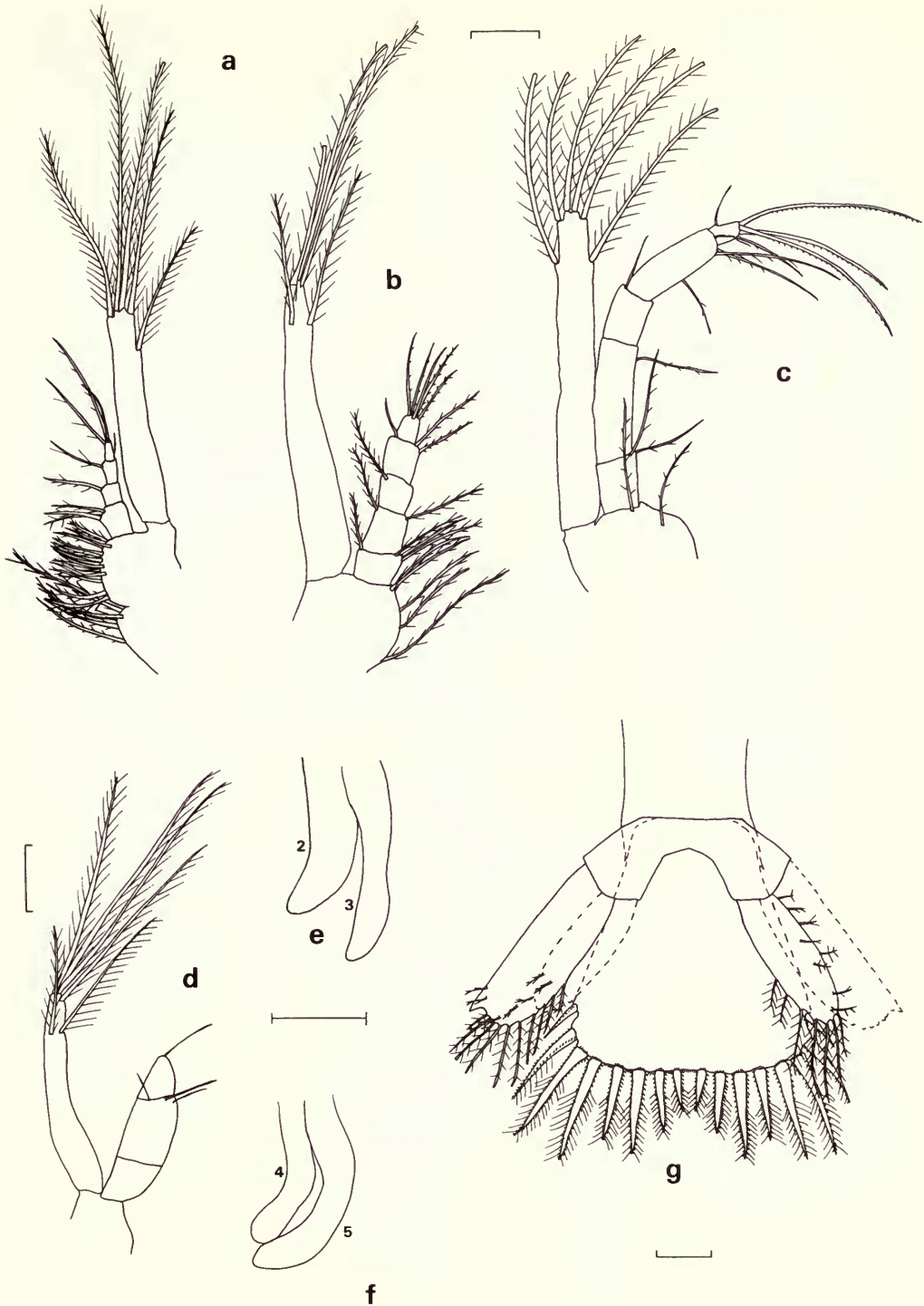


Fig. 5 Zoea 4: (a) maxilliped 1; (b) maxilliped 2; (c) maxilliped 3; (d) pereopod 1; (e) pereopods 2 & 3; (f) pereopods 4 & 5; (g) telson.
 Bar scales: a-g = 0.1 mm.

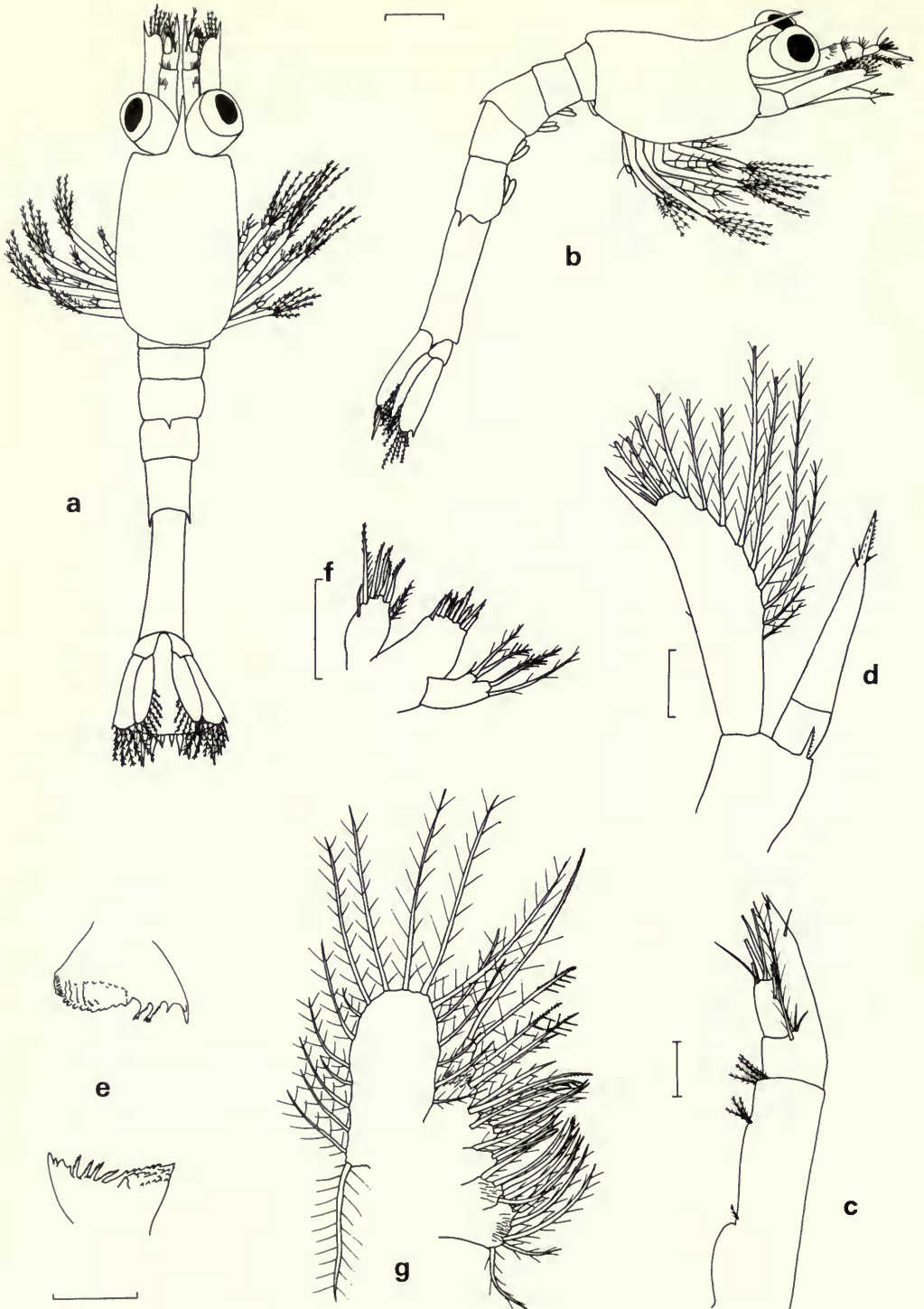


Fig. 6 *Zoea 5*: (a) dorsal view; (b) lateral view; (c) antenna 1; (d) antenna 2; (e) mandibles; (f) maxilla 1; (g) maxilla 2.
 Bar scales: a, b = 0.3 mm; c-g = 0.1 mm.



Fig. 7 Zoea 5: (a) maxilliped 1; (b) maxilliped 2; (c) maxilliped 3; (d) pereiopod 1; (e) pereiopods 2 & 3; (f) pereiopods 4 & 5; (g) telson.
 Bar scales: a-g = 0.1 mm.

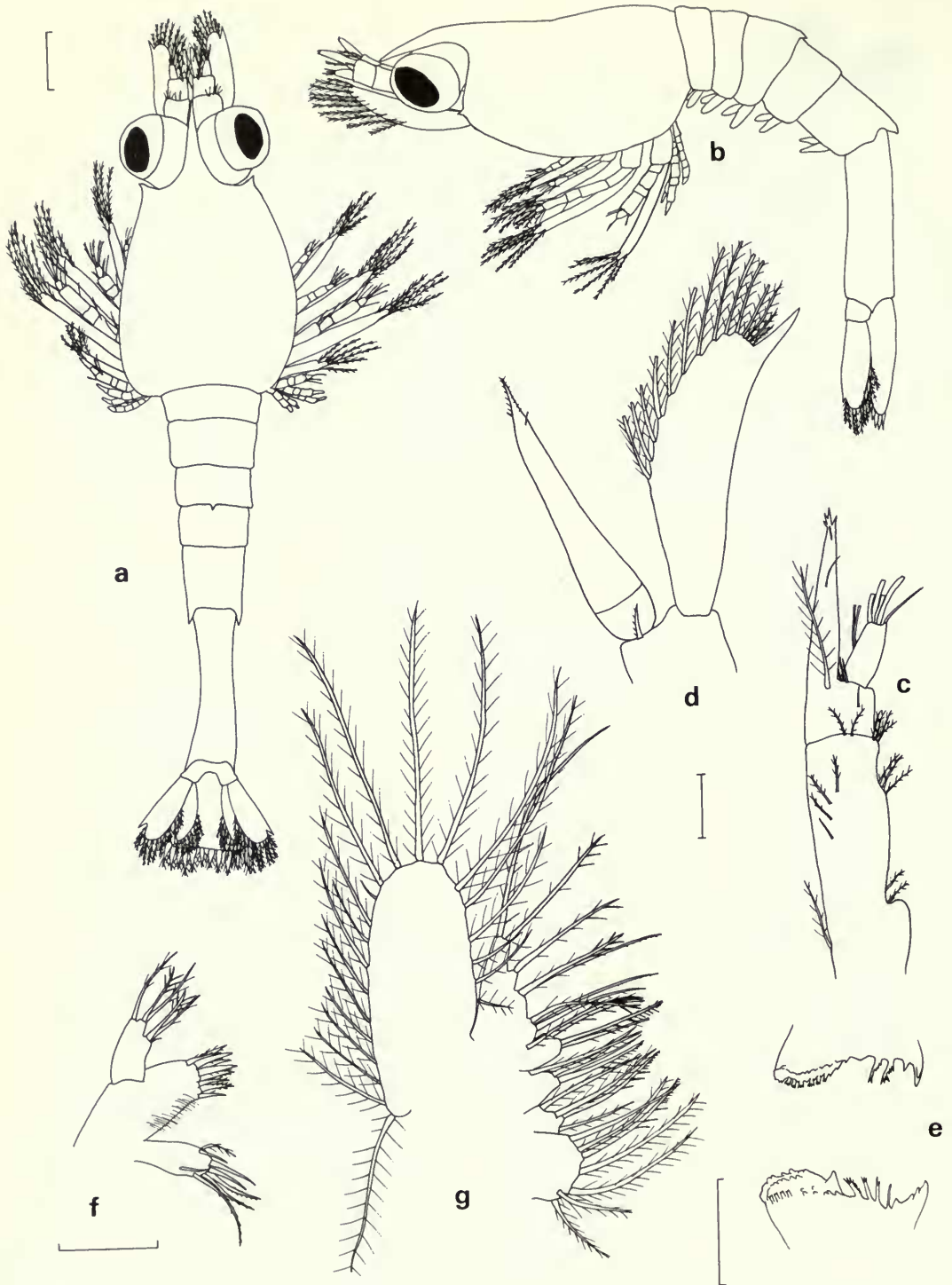


Fig. 8 Zoea 6: (a) dorsal view; (b) lateral view; (c) antenna 1; (d) antenna 2; (e) mandibles; (f) maxilla 1; (g) maxilla 2.
Bar scales: a, b = 0.3 mm; c-g = 0.1 mm.

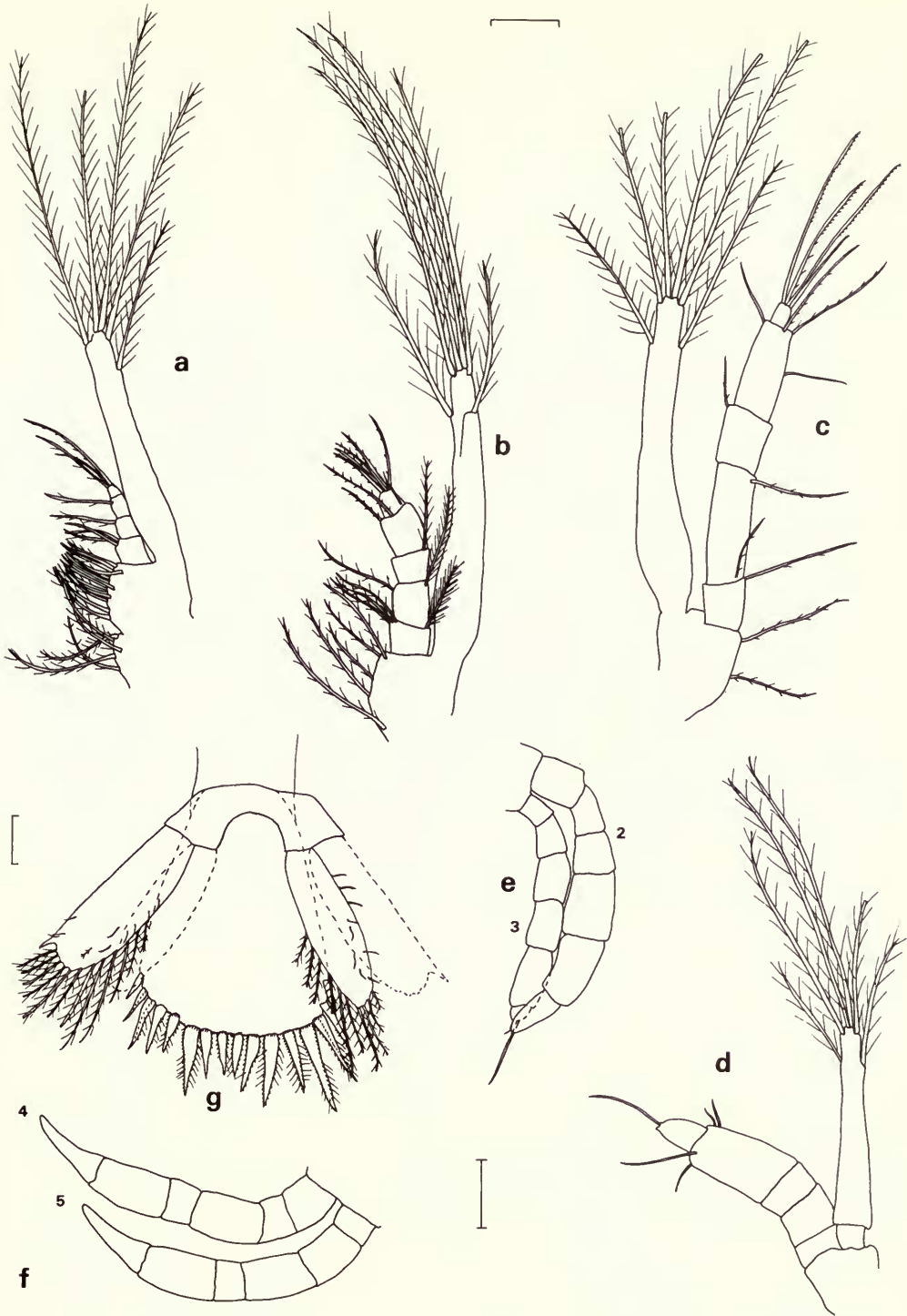


Fig. 9 Zoea 6: (a) maxilliped 1; (b) maxilliped 2; (c) maxilliped 3; (d) pereopod 1; (e) pereopods 2 & 3; (f) pereopods 4 & 5; (g) telson.
 Bar scales: a-g = 0.1 mm.

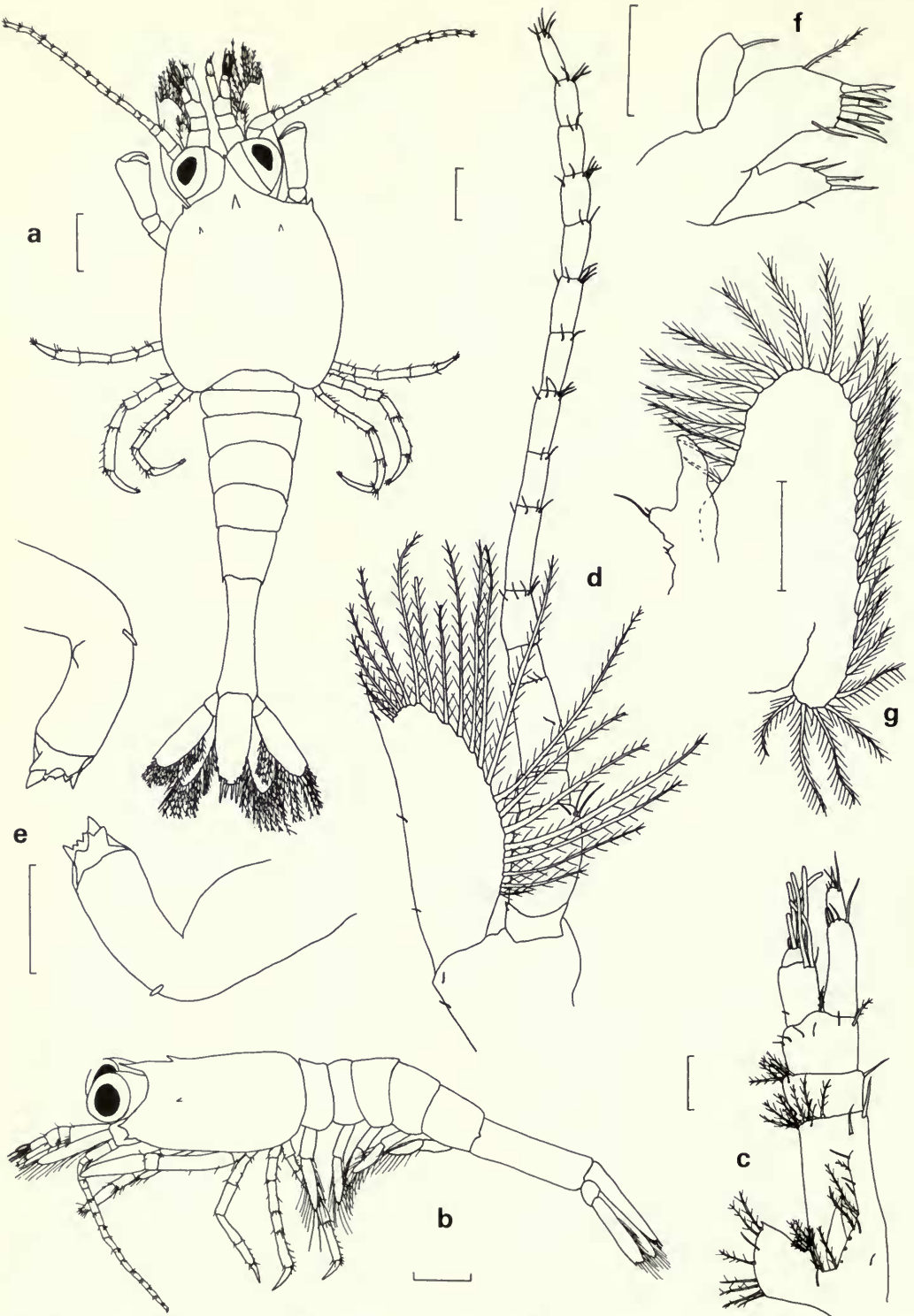


Fig. 10 Post Larva 1: (a) dorsal view; (b) lateral view; (c) antenna 1; (d) antenna 2; (e) mandibles; (f) maxilla 1; (g) maxilla 2.
 Bar scales: a = 0.35 mm; b = 0.4 mm; c-g = 0.1 mm.

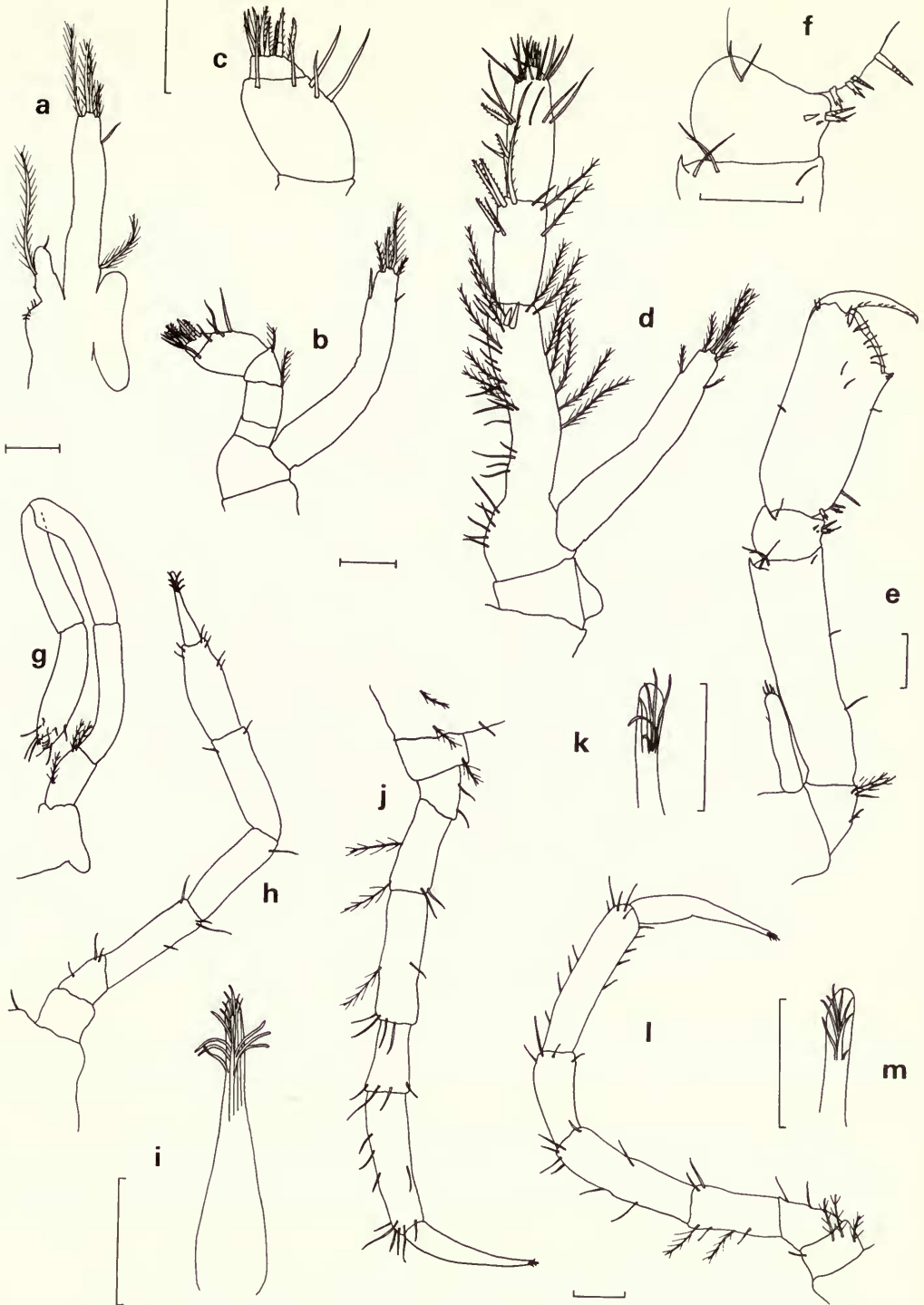


Fig. 11 Post Larva 1: (a) maxilliped 1; (b) maxilliped 2; (c) detail of endopod of maxilliped 2; (d) maxilliped 3; (e) pereiopod 1; (f) detail of pereiopod 1; (g) pereiopod 2; (h) pereiopod 3; (i) detail of terminal segment pereiopod 3; (j) pereiopod 4; (k) detail of terminal segment pereiopod 4; (l) pereiopod 5; (m) detail of terminal segment pereiopod 5. Bar scales: a-m = 0.1 mm.

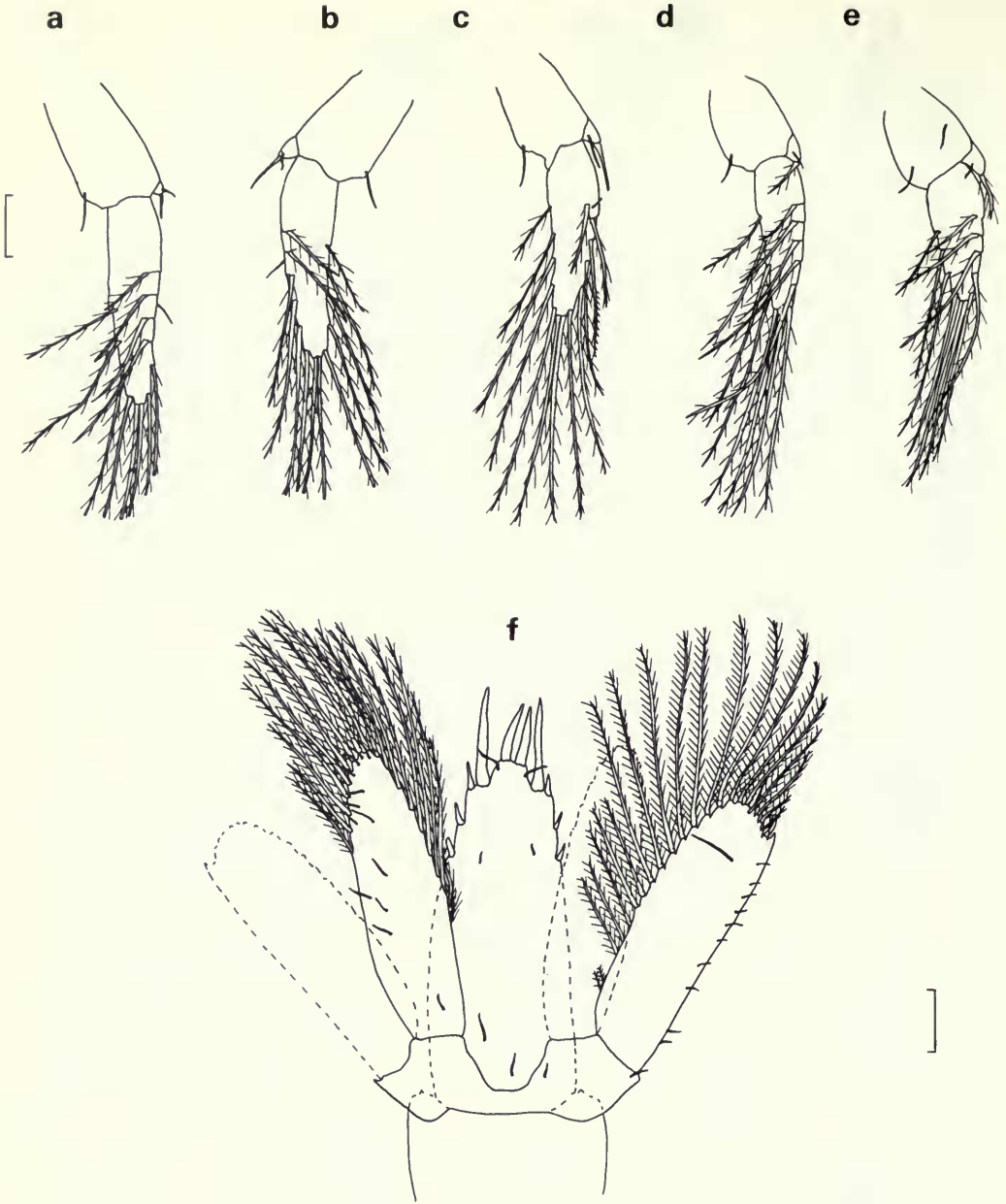


Fig. 12 Post Larva 1: (a) pleopod 1; (b) pleopod 2; (c) pleopod 3; (d) pleopod 4; (e) pleopod 5; (f) telson.

Bar scales: a-f=0.1 mm.